

# PATENT SPECIFICATION



Convention Date (United States) : March 4, 1927.

286,313

Application Date (In United Kingdom) : March 3, 1928. No. 6712/28.

Complete Accepted : Nov. 1, 1928.

## COMPLETE SPECIFICATION.

### Improvements in or relating to Aeroplane Landing Gear.

We, CURTISS AEROPLANE AND MOTOR COMPANY, INC., incorporated under the laws of the State of New York, United States of America, of Garden City, Long

5 Island, New York, United States of America, Assignees of REX BURLEN BEISEL, of Hempstead, Nassau County, New York, United States of America, a citizen of the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

15 This invention relates to aeroplane landing gears.

An object of the invention is to provide, in an aeroplane landing gear, a landing gear wheel in which the rim, the web and 20 the axle portion of the wheel, are all rotatable as a unit, and in which said web portion is offset laterally in its relation to a plane passing vertically through the circumferential center line of said rim.

25 A further object of the invention is to provide a landing gear wheel in which the axle portion thereof is journaled in a non-rotatable guide along which a fitting is adapted to move up and down in response 30 to varying impact loads encountered in the operation of the landing gear.

A further object of the invention is to provide an aeroplane landing gear in which the supporting strut or struts are 35 fastened to and are adapted to move vertically with said fitting.

A further object of the invention is to provide an arrangement whereby said fitting, and hence the landing gear strut 40 or struts attached thereto, in moving along said guide, are free to move back and forth, across and beyond said axle.

A further object of the invention is to provide an aeroplane landing gear in 45 which the shock absorbing means for yieldingly restraining the movement of said strut or struts is completely enclosed within the confines of the landing gear wheel.

50 A further object of the invention is to provide an aeroplane landing gear in which the shock absorbing means is a combination unit embodying the funda-

mental characteristics of both the oleo and the compression rubber disk type shock absorber. 55

A further object of the invention is to provide a shock absorber comprising separate shock absorbing units, the units, in each instance, being of a duplicate construction and being disposed respectively, one each at opposite sides of said guide. 60

A further object of the invention is to provide an aeroplane landing gear in which, in addition to the shock absorbing means, suitable hydraulic wheel brake mechanism is also completely enclosed within the confines of the landing gear wheel. 65

A still further object of the invention is to provide an aeroplane landing gear in which the inner periphery of the rim of the landing gear wheel is so formed and related to the wheel brake mechanism contained therein as to constitute a brake surface against which the wheel brake or brakes, when applied, is or are adapted to frictionally bear. 70

Other objects and advantages of the invention will be hereinafter set forth. 80

In the accompanying drawings, wherein like reference characters denote like or corresponding parts.

Fig. 1 is a front elevation of the landing gear; 85

Fig. 2 is a side elevation;

Fig. 3 is a side elevation of that part or portion of the landing gear enclosed within the confines of one of the landing gear wheels; 90

Fig. 4 is an enlarged transverse vertical sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is a similar view in which the section is taken on an irregular line removed somewhat to the right of the section line 4—4 of Fig. 3; 95

Fig. 6 is a fragmentary sectional view taken in a plane at right angles to that of Fig. 4;

Fig. 7 is a view similar to Fig. 6 showing the position of the landing gear parts as influenced by the application of an impact load; 100

Fig. 8 is an enlarged sectional view taken on the line 8—8 of Fig. 3; 105

Fig. 9 is a similar view taken on the line 9—9 of Fig. 3, and

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 6.

5 In the embodiment of the invention selected for illustration, an aeroplane landing gear of somewhat more or less conventional appearance is shown. Such a landing gear comprises, in addition to the wheels 10 thereof, a plurality of landing gear struts 11, 12, 13 and 14. The struts 11, 12 and 14 of the landing gear are rigidly fastened at one end to and within the fuselage or body 15 of the machine, whereas the struts 13 are fastened to each other. The struts 14, which are convergent, support at their outer ends the struts 13, and the latter, from said point of support, diverge downwardly for connection at their opposite ends with the struts 11—12. The struts 11—12, it will be noted, are arranged, one each at opposite sides of the fuselage and are, with respect to each other, substantially V-shaped, to provide in the aggregate two downwardly divergent substantially rigid triangular landing gear frames each carrying, at its outer end, one of the landing gear wheels.

30 The wheels 10 of the landing gear are exactly alike. Each comprises a rim portion 16, a web portion 17 and an axle portion 18. The rim portion 16 is shaped in cross-section as best illustrated in Fig. 4. Throughout its inner margin it is circumferentially reinforced by a tubular ring 19 permanently fastened against the inner face of the inside flange of the rim. The outer or opposite rim flange, unlike the inner rim flange, has fastened thereto the web portion 17 of the wheel. Said web portion is preferably located wholly at one side of a plane passing through the circumferential center line of the rim. It 45 is constructed in disc form and comprises a main casting 20, radially reinforced as at 21, and a cover plate 22. The casting 20 is laterally bellied out and has formed thereon a hub portion 23 within which is snugly fitted, as by shrinking, the outer enlarged end of the axle portion 18 of the wheel. Said axle portion is hollow throughout and in addition to the snug-fit in the web hub 22, it is further fastened 55 to said web as by bolts 24 which penetrate both the casting 20 and the cover plate 22 as well as an annular flange 25 formed on said axle portion to bear directly against the inner face of the web. 60 Throughout that portion of its length inwardly removed from said flange 25, said axle portion 18 is journaled in a bearing 26 mounted within and at the exact center of the wheel rim, and, as said 65 journal or bearing 26 is fixed in its rela-

tion to said wheel, obviously the wheel (including the rim, web and axle portion) is freely rotatable as a unit. A nut 27 threaded into the hollow of said axle portion, and removable, serves as a means for fastening the wheel in place. To lubricate 70 said wheel axle, a grease cup 28, threaded in the journal wall, is provided.

The bearing 26 within which the wheel 10 is journaled is preferably formed in a suitable guide 29. This guide 29 extends diametrically across and within the wheel rim and comprises spaced parallel side walls 30 and a connecting web 31. Upon each side wall 30 of the guide two guide rails 32 of channel section are fastened. Like the guide 29, the guide rails 32 extend vertically. Collectively, said rails 32 define two parallel guide-ways within which a master fitting (to be hereinafter more fully described) is slideable back and forth along said guide across and beyond the bearing 26 within which the axle portion of the wheel 10 is journaled.

90 The master fitting, designated in its entirety as 33, is directly fastened to a plate fitting 34 carried by the landing gear struts. Said fittings 33 and 34 and the struts 11, 12 and 13 of the landing gear, move at all times and under all operating conditions as a unit. As best illustrated in Fig. 9, the master fitting 33 comprises a flat plate-like body portion 35, arms 36, and rail engaging plates 37. The arms 36 are integrally formed on the outer face of said body portion and extend out therefrom in spaced parallel relation, one each on opposite sides of the guide 29. At their outer ends, said arms 36 have 105 enlargements 38 formed thereon. These enlargements extend toward one another and have bolted thereto the rail engaging plates 37 which are adapted to slide vertically within the guide-ways formed by the channel rails 32. Said plates 37 moreover by their fitting engagement in the channel rails, hold the guide 29 against rotation.

110 As the master fitting 33 is, in the absence of either a static load or an impact load, adapted to occupy a position at the upper end of the guide 29, said guide, at its upper end, has formed thereon two oppositely extending lugs 39. 120 These lugs 39 project laterally out from the side walls of the guide and extend into the guide-ways defined by the rails 32. Each said lug 39 has fastened thereto on its underside a re-bound shock absorber 125 40 against which the master fitting 33 is adapted to bear when retracted. To avoid all interference between said master fitting and said re-bound shock absorbers 40, the extensions 36 of the fitting and 130

the plates 37 thereof are cut away as indicated at 41.

The means for resisting the sliding movement of the master fitting 33 along the guide 39 comprises, in combination, an oleo and a compression disc type shock absorber. Both said oleo means and said compression disc means are duplicated for each strut group and in each case are confined to the space within the wheel rim at opposite sides of the guide. The oleo means, in its general make-up, and except for the duplication aforesaid, is not a great deal unlike the oleo type shock absorber now used. It comprises, in duplicate, a small diameter cylinder 41<sup>1</sup>, a large diameter cylinder 42, a head plate 43, and a cup-shaped member 44. The small diameter cylinders 41, in each instance, telescope within the large diameter cylinders 42, each pair, at the joint therebetween, being effectually sealed by a packing nut 45. The large diameter cylinders, at their lower ends, are flexibly supported in said cup-shaped members 44. Said cup-shaped members 44 are in turn carried by brackets 46 bolted as at 47 to the guide 29, one each at its opposite sides. These brackets are mounted at the foot of said guide and, with said cup-shaped members 44 hold the large diameter cylinders in an upright or substantially vertical position and at the same time hold said large diameter cylinders in that position affording a maximum of cylinder length. The small diameter cylinders 41<sup>1</sup> instead of being fastened to the guide 29, are fastened to the head plates 43. Said head plates are, in each instance, bolted as at 48 to brackets 49 carried, one each at opposite sides of the master fitting 33. Preferably the brackets 49 (see Figs. 6 and 7) are appropriately lightened and so formed as to provide on the under-surface thereof a bearing wall 50 within which an opening 51 is formed. The small diameter cylinders, as further indicated in said figs., extend through these openings 51 as well as throughout the length or depth of said brackets to the end that a maximum of cylinder length may be obtained within the upper portion of the wheel. The head plates 43 to which the small diameter cylinders are fastened, are mounted on the top bracket wall and are movable vertically as the cylinders telescope with said master fitting along the vertical guide 29. A check valve 52 is provided at the foot of each small diameter cylinder to govern the transfer of the oil or other fluid from one to the other of the cylinders comprising the respective pairs in the operation of the oleo means. Moreover, in view of the restricted space within which the cylin-

ders 41<sup>1</sup> and 42 are confined, there may be provided at a remote point, an oil reservoir 53 within which the oil contained in the cylinders 41<sup>1</sup> and 42 is free to back up during the operation of said oleo means. As herein shown, such reservoir 53 is carried at or near the foot of one of the landing gear struts and is connected to both small diameter cylinders by oil lines 54 which lead respectively to ducts 55 formed in the head plates 43.

The compression disc type shock absorber, like the oleo unit, is also duplicated at opposite sides of the guide 29. It comprises essentially two tiers of rubber discs 56 arranged to encircle the large diameter cylinders of the oleo unit. Said tiers of discs bear at their lower ends directly on the brackets 46 which support the large diameter cylinders and at their opposite ends terminate at points sufficiently removed from the brackets 49 to admit of the downward movement thereof throughout a substantial portion of the length of the guide before the bottom wall 50 of said brackets is brought into bearing contact with said tiers of discs. In other words, no shock whatsoever is borne by the tiers of discs during the initial movement of the master fitting—said discs being active as shock absorbing devices only after said master fitting shall have been moved sufficiently along the guide 29 to bring said brackets into bearing contact with the separate tiers of discs. From such time onward, during each successive down stroke of the master fitting, the rubber disc units and the oleo units operate jointly and in combination. In this connection it will be noted that the openings 51 formed in the bracket walls are of sufficient size to receive therewithin the large diameter cylinders and the packing nuts 45 threaded thereon when said brackets are forced downwardly in operation.

In addition to the re-bound shock absorbers 40 mounted at the upper end of the guide 29, there is provided, at said upper guide end, two duplicate yokes or frames 57. These frames 57 extend out oppositely from said guide on either side thereof. They are bolted in place as at 58 to the inside walls 34 of the guide, and, from their points of attachment, reach out and around back of the guide as illustrated in Figs. 8 and 9. At their outer end said yokes 57 have formed thereon suitable head portions 59 which occupy positions so related to the brackets 49 in each instance, as to admit of the use of tension elastics as an interconnection therebetween. The function of these elastics, designated as 60, is to assist in the return movement of the master fitting

33. In the absence of said elastics 60 considerable time would be required to effect, by gravity alone, the transfer of the oil from the small diameter to the 5 large diameter cylinders of the oleo shock absorbing means.
- Referring next to the hydraulic brake mechanism of the invention, 61 designates a master cylinder of ordinary design. 10 Preferably said cylinder 61 is located within the fuselage or body of the aeroplane in convenient proximity to the operator's seat and is connected by a feed line 62 with an operating cylinder 63. 15 Said operating cylinder 63, as herein illustrated, is rigidly fastened to the upper end of the guide 29 and contains within its defining wall two appropriately spaced plungers or pistons 64. These pistons 64 20 are adapted to be simultaneously moved apart by building up within the pipe line 62, and hence the cylinder 63, a pressure sufficient to operate the brakes. The brake shoes, of which there are two, designated 25 as 65, are wholly enclosed within the wheel rim. Each said shoe, at the foot of the guide 29, is pivoted as at 66 to a fitting 67 fastened to said guide. From their points of attachment the two shoes 30 extend oppositely along the inner periphery of the wheel rim, each throughout substantially half the circumference of the wheel. At their opposite ends said shoes are pivotally fastened as at 68 to link connections 69 which bear at one end 35 on the pistons 64 of the operating cylinder. Thus arranged, as the pistons 64 are forced apart, the brakes 65 are simultaneously moved into frictional contact with the inner wall of the wheel rim. By lining the brake shoes as indicated and letting the inner periphery of the wheel rim act as a brake drum or brake surface, 40 an exceptionally simple and at the same time highly efficient hydraulic brake mechanism is evolved. Springs 70, fastened at one end to said brake shoes and at their opposite ends fastened to the yokes 57, normally hold said brake shoes 45 out of contact with the wheel rim. Moreover, if desired, the expanding and contracting movement of said brake shoes 65 may be guided by extensions 71 formed on said yokes 57 at their outer ends.
- An aeroplane landing gear characterized as above set forth is especially desirable when used on and in connection with shipboard aeroplanes. The action of the oleo shock absorbers is such that the initial or 60 landing load is fully absorbed, and the tendency to re-bound wholly eliminated. Its desirability for shipdeck landing is in fact so pronounced that provision is made in the embodiment disclosed for the suspension of landing hooks from a cross-
- connection extending from one to the other of the landing gear wheels. Such connection is designated herein as 72. At its opposite ends said connection is rigidly though removably fastened to fitting 73 carried at the foot of the divergent strut groups, which fittings, in addition to providing suitable anchorages for said cross-connection also serve as bearing surfaces against which jacks may be placed to jack-up the machine should occasion require. Moreover, as hereinbefore pointed out, our improved landing gear combines, for the first time, insofar as we are aware, the fundamental characteristics of both the oleo and the compression rubber disc types of shock absorber. Certainly, the present invention is the first instance in which a combination shock absorber of the character mentioned, together with suitable hydraulic brake mechanism, is wholly confined within the limits of the aeroplane wheels.
- While we have described our invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art after understanding our invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. We aim in the appended claims to cover all such modifications and changes.
- Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:
1. An aeroplane landing gear including a wheel whereof the axle portion is journaled in a non-rotating guide along 105 which a strut fitting pertaining to the aeroplane is adapted to move under varying loads and against the resistance of a shock absorber from a position above the wheel axle portion to a position below said 110 axle portion.
  2. An aeroplane landing gear according to Claim 1, in which the normal position of the strut fitting is well above the axle portion of the wheel near the top of 115 the guide which is substantially vertical and extends diametrically across the wheel.
  3. An aeroplane landing gear including a wheel across the axis of which a strut fitting pertaining to the aeroplane is adapted to move against the action of a combined oleo and rubber disc shock absorber.
  4. An aeroplane landing gear including 125 a wheel within which is enclosed a brake and a shock absorber, the latter resisting the movement across the axis of the wheel of a strut fitting pertaining to the aeroplane.

5. An aeroplane landing gear according to Claim 4, including means, preferably of a hydraulic nature, for moving the brake into and out of contact with the inner surface of the rim. 30
6. An aeroplane landing gear according to Claim 4 or 5, in which the brake is carried by a guide in which the wheel is journaled and along which the strut fitting is movable. 35
7. An aeroplane landing gear including a wheel within which are enclosed a guide for a strut fitting pertaining to the aeroplane and a shock absorber for resisting movement of said fitting along the guide and across the axis of the wheel, the fitting being substantially U-shaped, and the guide engaging between the spaced arms thereof and being prevented from rotation by such engagement. 40
8. An aeroplane landing gear according to any one of the preceding claims, in which the shock absorber comprises separate units positioned at opposite sides 25 of the strut fitting.
9. An aeroplane landing gear according to any one of the preceding claims, in which the shock absorber is of the compression type. 45
10. An aeroplane landing gear according to any one of the preceding claims, in which the shock absorber includes an abutment by means of which movement of the strut fitting is yieldingly limited. 30
11. An aeroplane landing gear according to any one of the preceding claims, in which the wheel includes a web portion and a rim, the web portion being located wholly at one side of a plane intersecting the circumferential center line of said rim and an annular ring reinforcing said rim on the opposite side of its circumferential center line. 35
12. An aeroplane landing gear substantially as hereinbefore described with reference to the accompanying drawings for the purpose specified. 40

Dated the 4th day of March, 1928.

For CURTISS AEROPLANE & MOTOR COMPANY, INC.,  
White, Langner, Stevens & Parry,  
Chartered Patent Agents,  
Jessel Chambers, 88-90, Chancery Lane,  
London, W.C. 2, and  
17, John Street, New York, U.S.A.

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FIG.1.

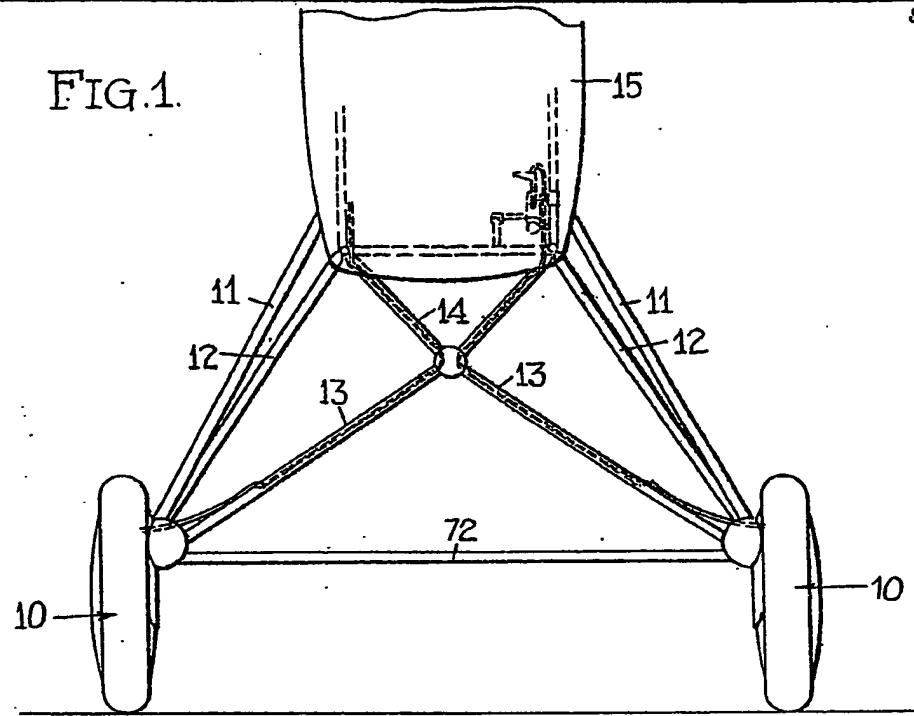


FIG.2.

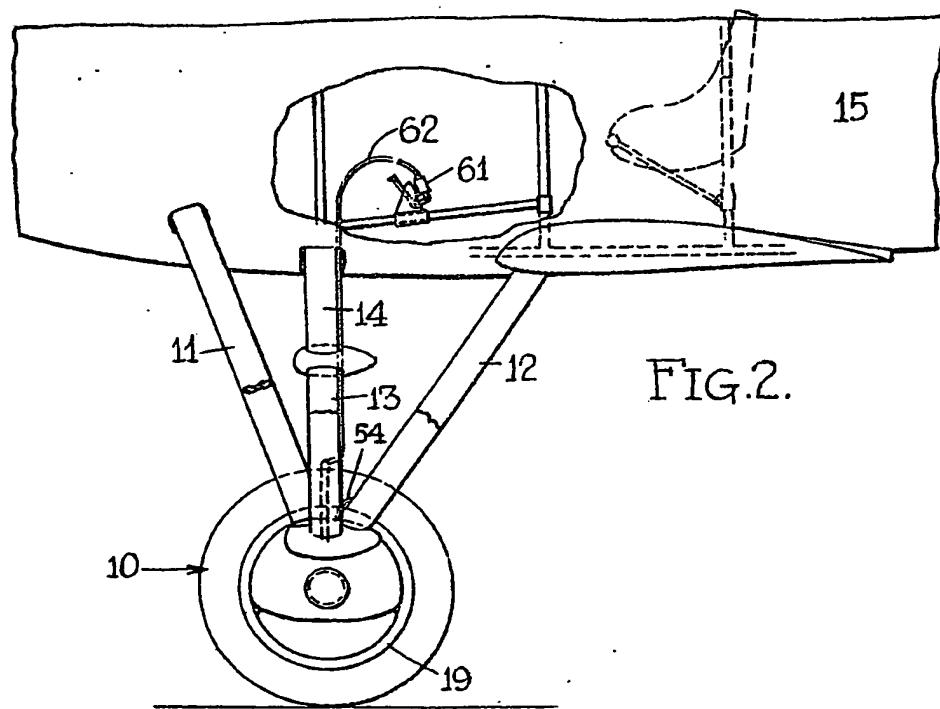
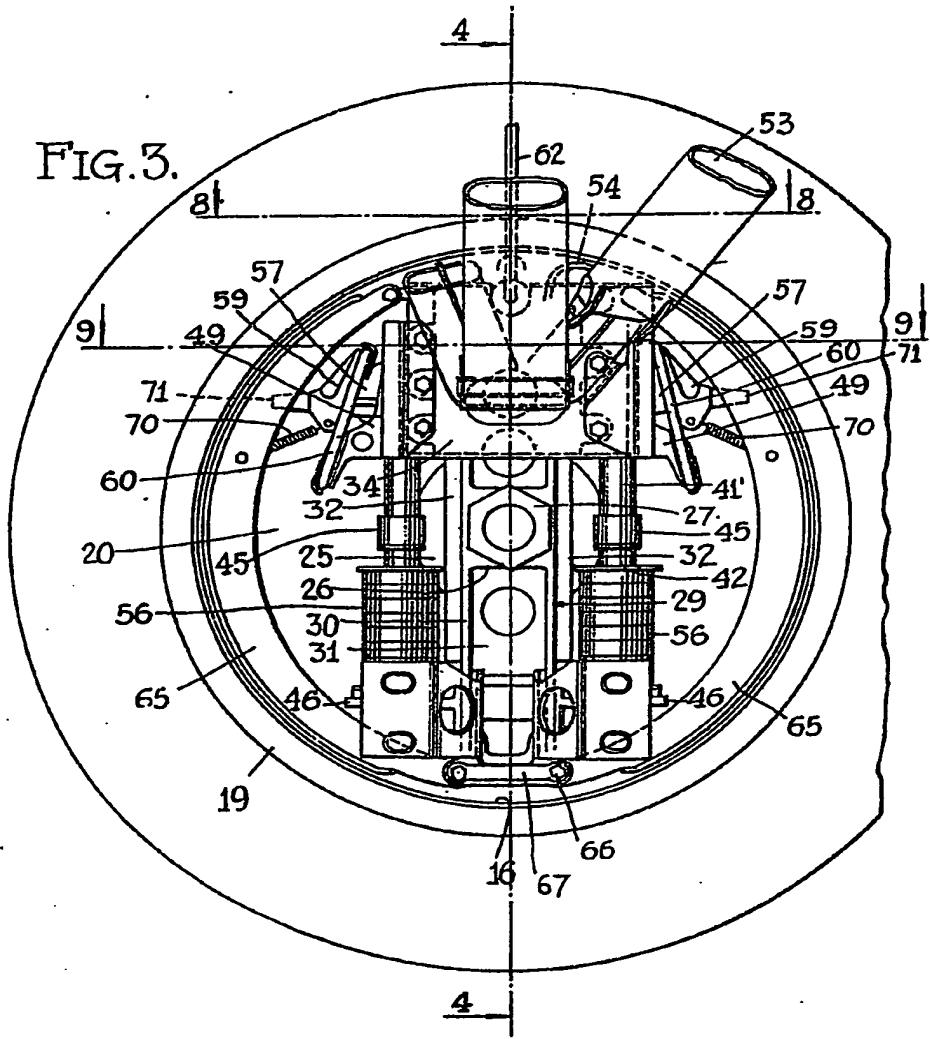


FIG. 3.



286,313 COMPLETE SPECIFICATION

SHEET 1

FIG.1.

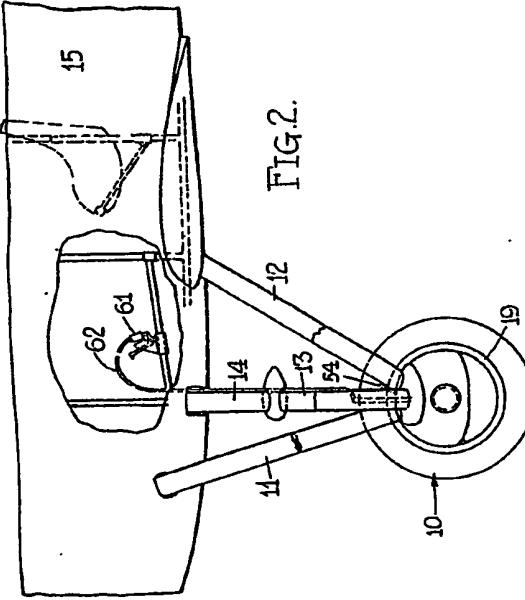
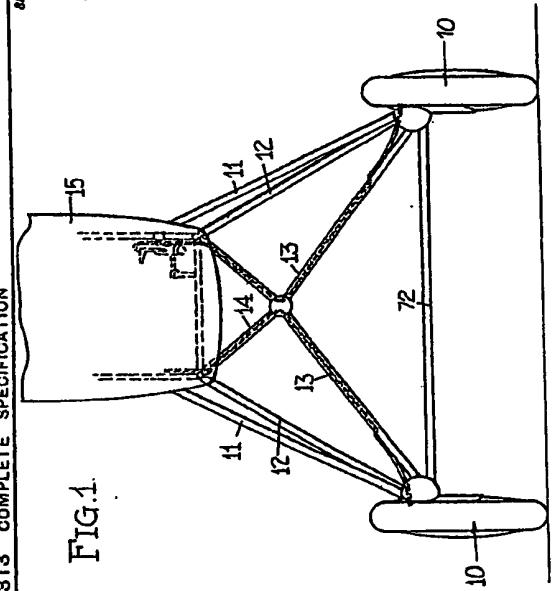
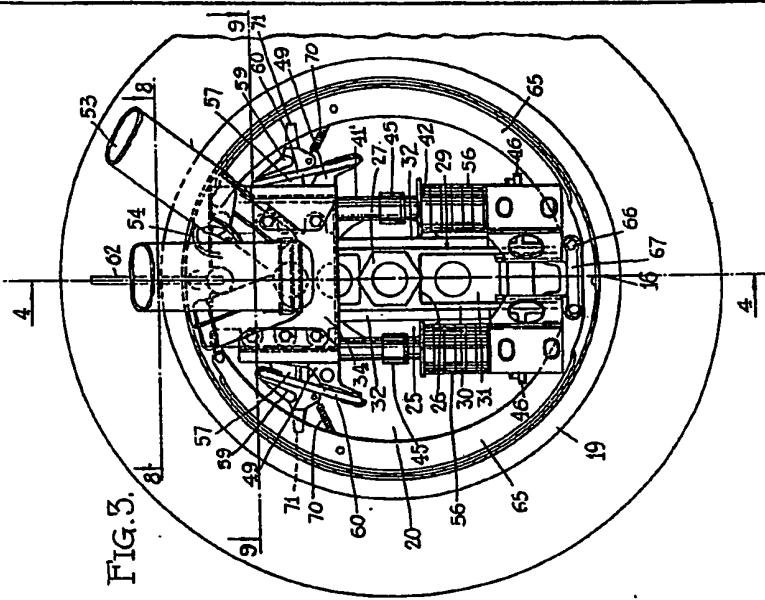


FIG.2.

SHEETS  
SHEET 2

FIG.3.



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SHEET 3

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FIG.4

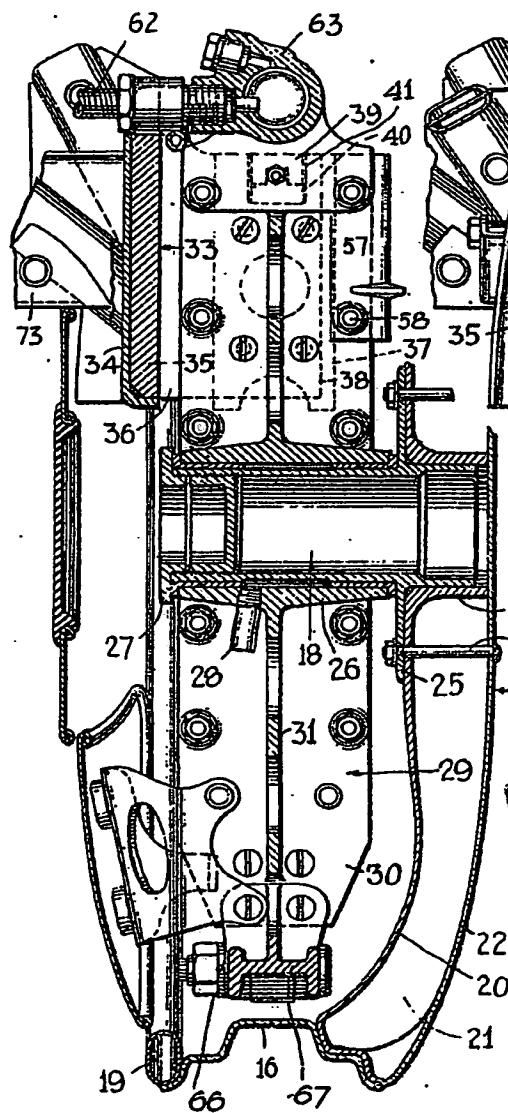
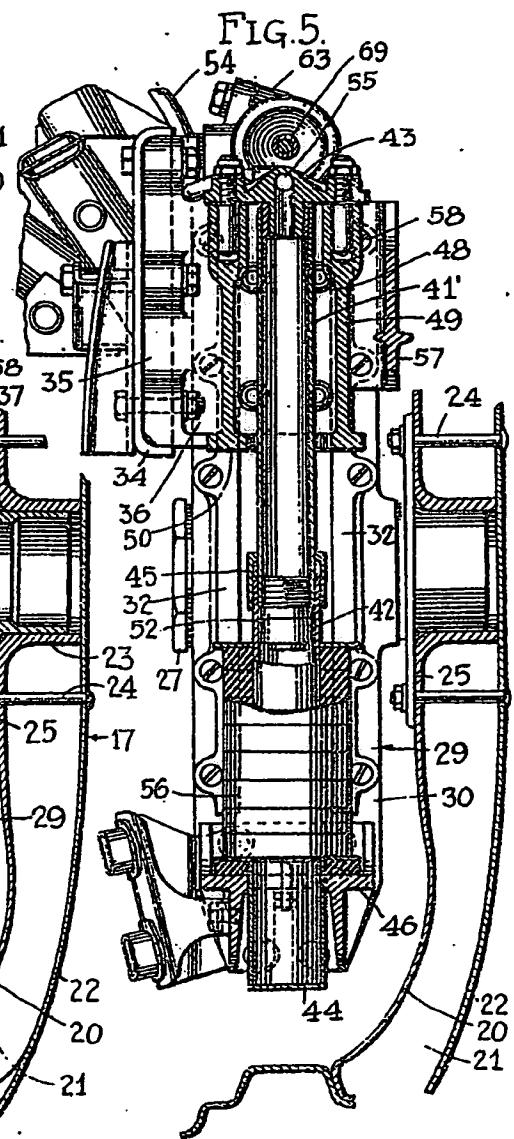
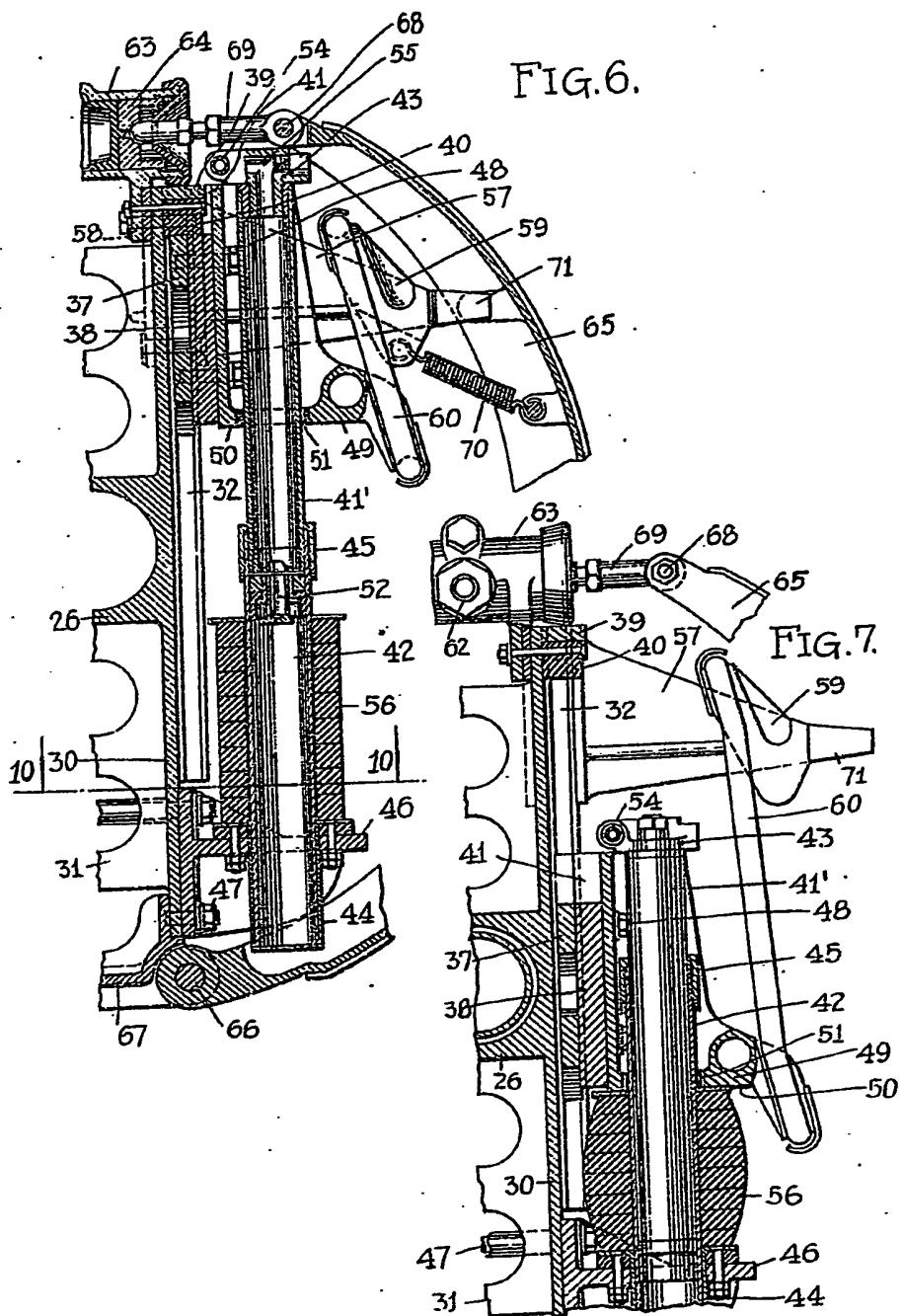


FIG.5



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38  
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SHEET 3

22  
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21

286.313 COMPLETE SPECIFICATION

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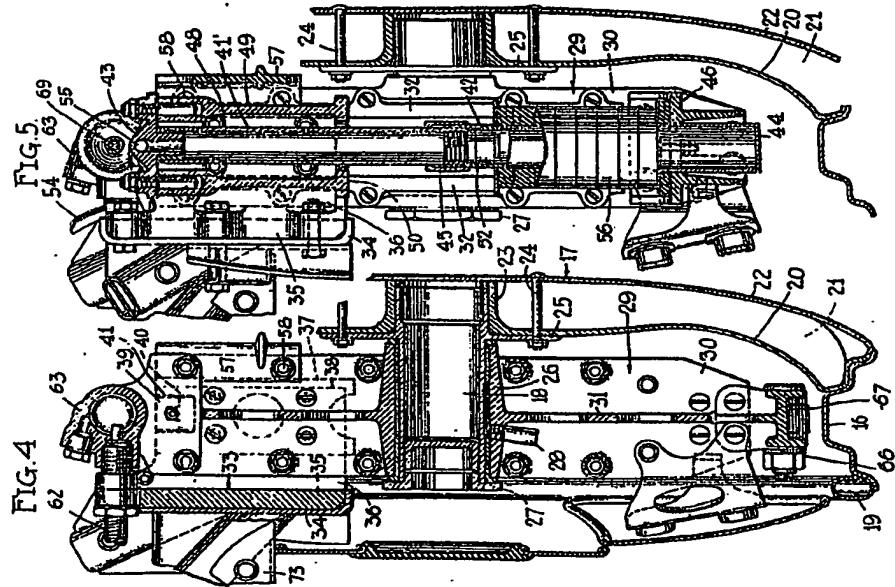
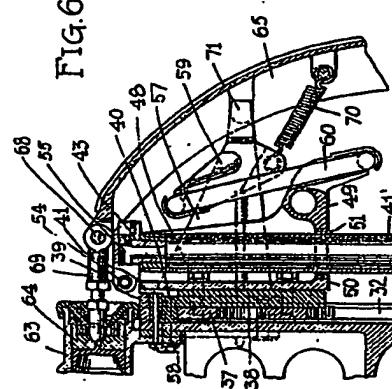
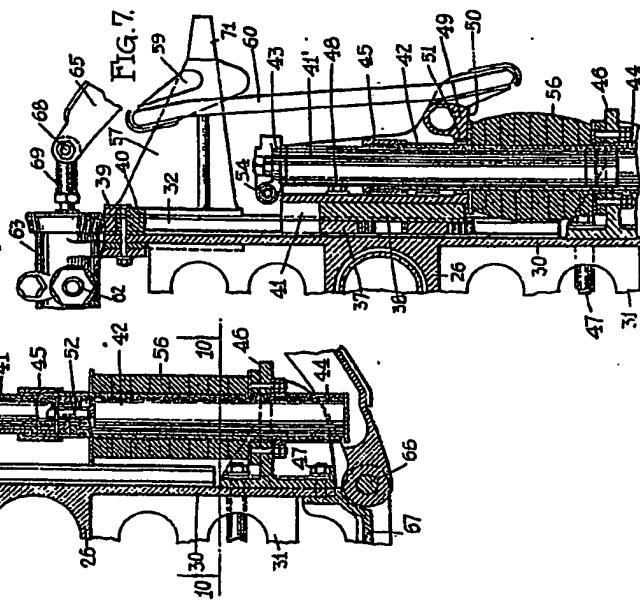


FIG. 6.



SHEET 1



57.

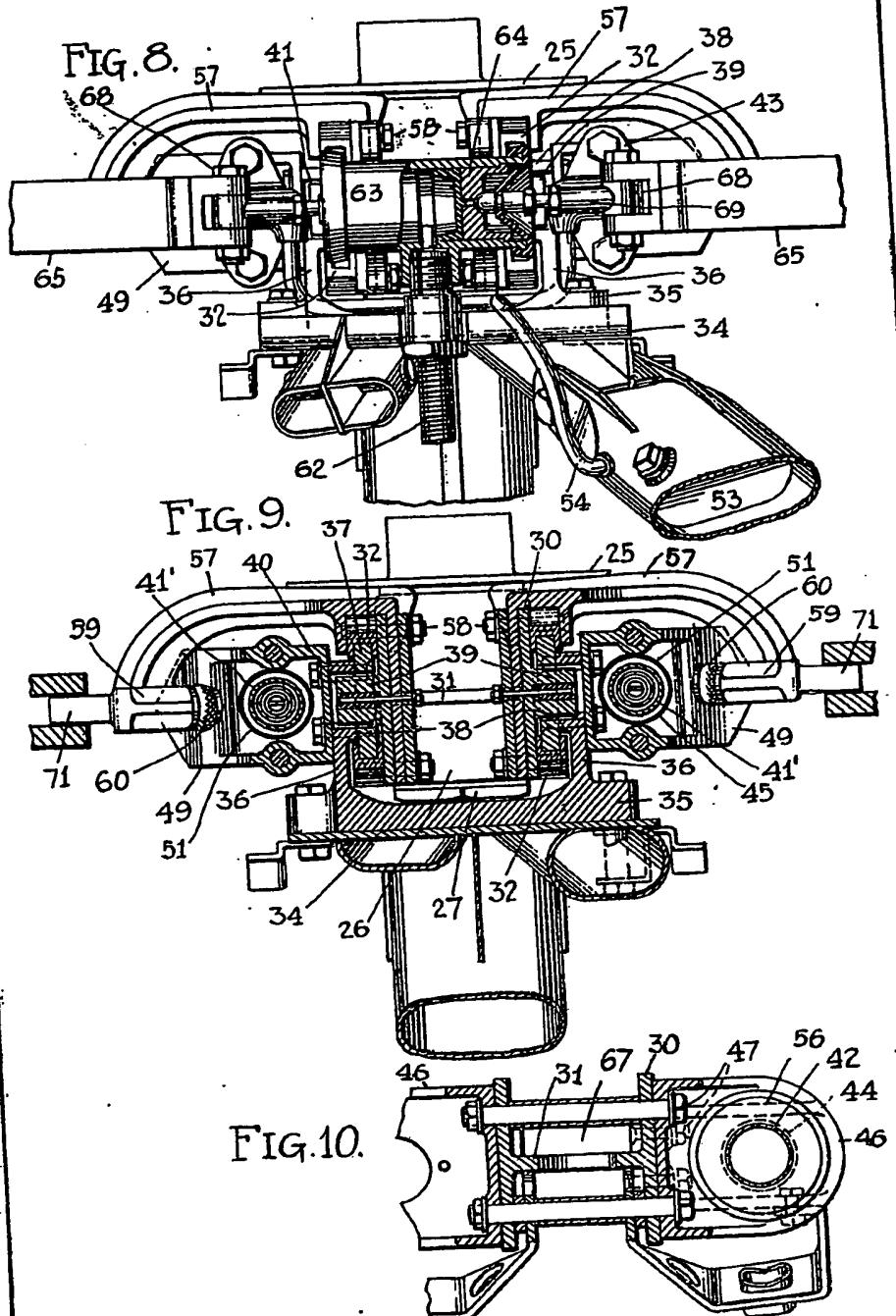
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**286.313 COMPLETE SPECIFICATION**

5 SHEET8  
SHEET 5

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